

1 Therefore, we claim:

2 1. A shape memory alloy (SMA) switch comprising:

3 a substrate;

4 a continuous SMA element attached to said substrate at first and second locations

5 and having a first portion and a second portion, said first portion contracting to place said

6 SMA element in a first conformation upon being heated above a predetermined

7 temperature and said second portion contracting to place said SMA element in a second

8 conformation upon being heated above said predetermined temperature; and

9 a cursor attached to said SMA element at a location substantially intermediate

10 said first and said second portions to reciprocate between a first position when said SMA

11 element is in said first conformation and a second position when said SMA element is in

12 said second conformation.

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14 2. The SMA switch of claim 1 further comprising a first contact arm situated adjacent

15 said cursor, said first contact arm having an open position and a closed position, said

16 cursor being in sliding contact with said first contact arm to move said first contact arm

17 from said open position to said closed position as said cursor moves from said second

18 position to said first position.

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20 3. The SMA switch of claim 2 wherein said first contact arm is electrically conductive.

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1 4. The SMA switch of claim 1 further comprising means for separately applying
2 sufficient heat to said first and said second portions of said SMA element to reciprocate
3 said cursor between said first and said second positions.
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5 5. The SMA switch of claim 2 further comprising a second contact arm and an
6 electrically conductive short bar disposed on said cursor to create first and second
7 electrical contact points, said first and second contact arms being biased to contact said
8 cursor such that, when said cursor is in said first position, said first and said second
9 contact arms are electrically coupled to each other via said short bar to close said SMA
10 switch, said bias of said first and said second contact arms providing a force to maintain
11 said cursor in said first position.
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13 6. The SMA switch of claim 2 wherein said cursor has two lateral side surfaces, one of
14 said lateral side surfaces having a first cut-away portion dimensioned to interlock with
15 said first contact arm and the other of said lateral side surfaces having a second cut-away
16 portion to interlock with a second contact arm such that said interlocking between said
17 lateral side surfaces and said first and second contact arms maintains movement of said
18 cursor substantially within a single plane as said cursor moves between said first and
19 second positions.
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21 7. The SMA switch of claim 5 wherein said first and second electrical contact points are
22 recessed within said cursor to receive said first and said second contact arms.
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1 8. The SMA switch of claim 1 wherein said first contact arm is situated within a travel
2 path of said cursor such that said first contact arm is displaced by said cursor as said
3 cursor moves from said second to said first position, said displacement bringing said first
4 contact arm into contact with a second contact arm to place said first contact arm into
5 said closed position.

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7 9. The bistable SMA switch of claim 8 wherein said cursor has a lateral surface in
8 contact with said first contact arm, said lateral surface including a projection located at a
9 position on said lateral surface such that as said cursor moves from said second position
10 to said first position, said first contact arm first encounters a first slope of said projection
11 that displaces said first contact arm into abutting engagement with said second contact
12 arm and as said cursor continues toward said first position, said first contact arm
13 encounters a second slope of said projection that permits displacement of said first
14 contact arm in a direction opposite to said displacement caused by said first slope as said
15 cursor moves from said second to said first position.

16
17 10. The SMA switch of claim of 9 wherein said second contact arm is biased to exert a
18 force on said first contact arm that has a component which is substantially perpendicular
19 to a direction of travel of said cursor between said first and second positions, said
20 component of said force acting against said projection to provide resistance against
21 movement of said cursor from said first to said second position.

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1 11. The switch of claim 4 wherein said means for separately applying heat comprises a
2 first electrical circuit that includes said first portion of said SMA element and a second
3 electrical circuit that includes said second portion of said SMA element, said first and
4 second circuits sharing a common ground fixedly attached to a mounting surface upon
5 which said substrate is mounted.

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7 12. The switch of claim 11 further comprising a spring component connected to said
8 SMA element to maintain an electrical connection between said SMA element and said
9 common electrical ground while permitting said SMA element to alternate between said
10 first and second conformations.

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12 13. The switch of claim 11 further comprising a brush element in sliding contact with
13 said common electrical ground, said brush element being connected to said SMA element
14 to maintain an electrical connection between said SMA element and said common
15 electrical ground while permitting said SMA element to alternate between said first and
16 second conformations.

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18 14. The switch of claim 11 wherein said common ground comprises a wire bond
19 electrically connecting said SMA element to said mounting surface via said cursor.

20
21 15. A bistable shape memory alloy (SMA) switch comprising:
22 a substrate;

1 a transducer connected to said substrate comprising a single continuous SMA
2 element having first and second conformations and including:
3 a) a first heating unit coupled to a first segment of said SMA element
4 to heat said first segment above a predetermined temperature
5 causing contraction of said first segment so that said SMA element
6 assumes said first conformation; and
7 b) a second heating unit coupled to a second segment of said SMA
8 element to heat said second segment above said predetermined
9 temperature causing contraction of said second segment so that
10 said SMA element assumes said second conformation;
11 a cursor coupled to said SMA element to reciprocate between first and second
12 positions as said SMA element alternates between said first and said second
13 conformations;
14 a first contact arm in sliding contact with said cursor to move from an open
15 position to a closed position as said cursor moves from said second to said first position.

16 16. The SMA switch of claim 15 wherein said first and second heating units respectively
17 comprise a first electrical circuit and a second electrical circuit, said first and second
18 electrical circuits sharing a common node on said SMA element.

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21 17. The SMA switch of claim 16 wherein said common node includes an electrical
22 ground fixedly attached to a mounting surface upon which said substrate is mounted and
23 a spring component extending from said electrical ground to said SMA element to

1 maintain electrical connectivity between said SMA element and said electrical ground
2 while permitting movement of said SMA element between said first and said second
3 conformations.

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5 18. The SMA switch of claim 16 wherein said common node includes an electrical
6 ground fixedly attached to a mounting surface upon which said substrate is mounted and
7 a brush element in sliding contact with said electrical ground and fixedly attached to said
8 SMA element to maintain electrical connectivity between said SMA element and said
9 electrical ground while permitting movement of said SMA element between said first and
10 said second conformations.

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12 19. The SMA switch of claim 15 wherein said cursor includes a short bar having first
13 and second contact points, said bistable SMA switch further comprising a second contact
14 arm wherein said first and said second contact arms are both biased to contact said cursor
15 such that, when said cursor is in said first position, said first and said second contact arms
16 are electrically coupled via said short bar, said first contact arm is mechanically coupled
17 to said first contact point, and said second contact arms is mechanically coupled to said
18 second contact point.

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20 20. The SMA switch of claim 19 wherein said first and said second contact points are
21 recessed into said cursor.

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1 21. The SMA switch of claim 15 further comprising a second contact arm, said first
2 contact arm being situated within a travel path of said cursor such that said first contact
3 arm is moved into said closed position to contact said second contact arm as said cursor
4 moves from said second to said first position.

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6 22. A shape memory alloy (SMA) switch comprising having open and closed states
7 comprising:

8 a substrate;

9 a single continuous SMA element connected to said substrate at first and second
10 locations and having first and second sections, said first section contracting to place said
11 SMA element into a first conformation upon being heated above a predetermined
12 temperature and said second section contracting to place said SMA element into a second
13 conformation upon being heated above said predetermined temperature;

14 a cursor coupled to said SMA element substantially between said first and said
15 second sections to reciprocate between first and second positions as said SMA element
16 alternates between said first and said second conformations;

17 a first contact arm biased toward said cursor for sliding contact with said cursor as
18 said cursor moves from said first to said second position, said first contact arm being
19 positioned within a travel path of said cursor so that as said cursor moves from said
20 second to said first position, said first contact arm becomes electrically coupled to a
21 second contact arm to trigger said closed state of said SMA switch; and

22 means for separately and independently heating said first and said second sections
23 of said SMA element.

1 23. The SMA switch of claim 22 wherein a bias of one of said first and said second
2 contact arms toward said cursor exerts a force on said cursor to maintain said closed state
3 of said switch when said cursor is in said first position.
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5 24. The SMA switch of claim 22 wherein said heating means includes a first electrical
6 circuit that includes said first section of said SMA element and a second electrical circuit
7 that includes said second section of said SMA element.

8
9 25. The switch of claim 24 wherein said first and said second electrical circuits share a
10 common node comprising an electrical ground fixedly attached to a mounting surface
11 upon which said substrate is mounted and a spring component connected to said SMA
12 element to provide electrical connectivity between said SMA element and said common
13 ground while permitting movement of said cursor between said first and said second
14 positions.
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16 26. The SMA switch of claim 24 wherein said first and said second electrical circuits
17 include a common node comprising an electrical ground fixedly attached to a mounting
18 surface upon which said substrate is mounted and a brush element in sliding contact with
19 said electrical ground and fixedly attached to said SMA element to provide electrical
20 connectivity between said SMA element and said common ground while permitting
21 movement of said cursor between said first and said second positions.
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